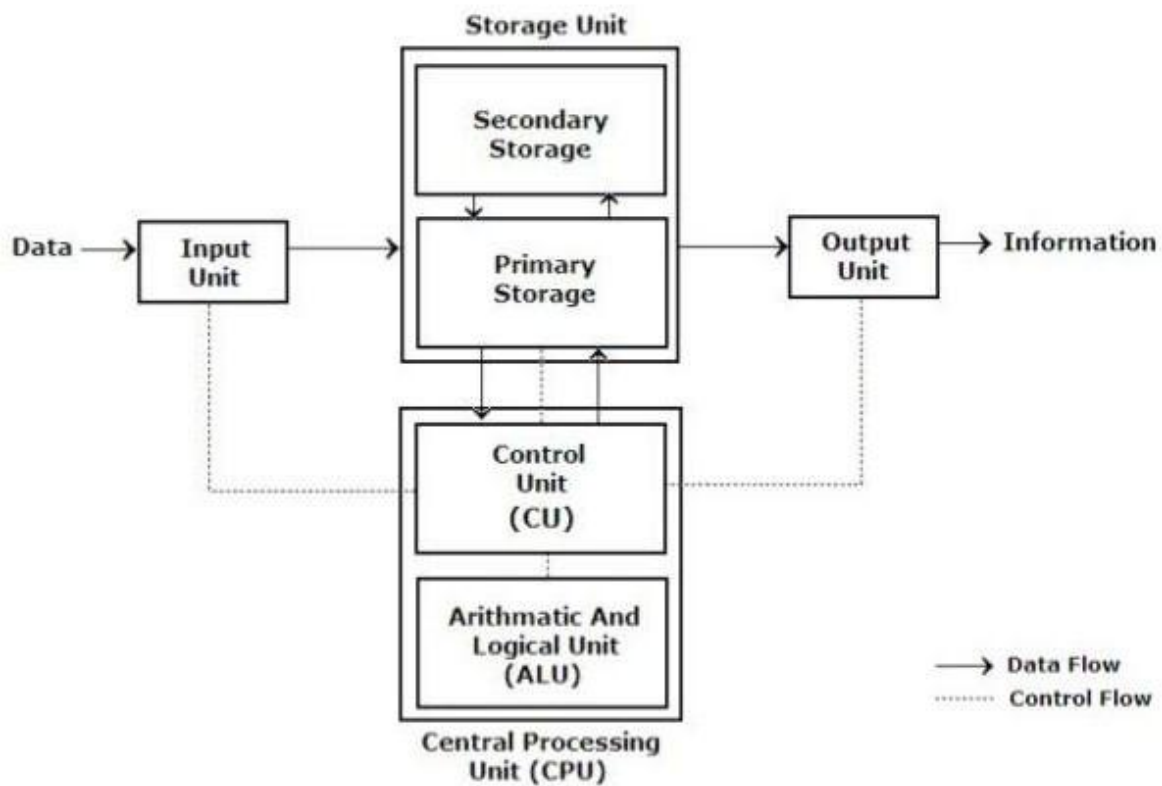


# UNIT: 2 BASIC COMPUTER ARCHITECTURE

## BLOCK DIAGRAM & FUNCTIONAL UNITS OF COMPUTER SYSTEM

- A computer system consists of various functional Units such as, **Input Unit, Output Unit, Central Processing Unit and storage unit.**
- Following is the block diagram that depicts various functional units.



### □ INPUT UNIT

- Data & instructions must be entered in to the computer system before any computation can be performed on the supplied data. The input unit is responsible for this task.
- The input unit links the external environment with computer system.
- Following are various activities performed by input unit:
  - 1) Accepts & reads the list of instructions & data from the outside world.

- 2) Converts these instructions & data in the computer acceptable form (means, binary code). This transformation is done by units called input interfaces.
  - 3) Supplies the converted instructions and data to the computer system for further processing.
- Examples of input devices are : keyboard, mouse, scanner, light pen, joysticks, OMR, OCR, MICR, barcode reader etc.

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#### □ OUTPUT UNIT

- The job of output unit is reverse of input unit.
- It links the computer system with external environment.
- Following are various tasks performed by output unit:
  - 1) Accepts results produced by the computer, which are in the coded form, that cannot be easily understood by us.
  - 2) It converts coded results into human acceptable form.
  - 3) It supplies the converted results to outside world.
- Examples of output devices are : printer, monitor, speaker, plotters etc.

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#### □ C.P.U.

- We can say that CPU is the heart of the computer.
- The CPU comprises of :
  - 1) Control Unit (CU)
  - 2) Arithmetic and logic Unit (ALU)
  - 3) Registers
- Control Unit (CU):
  - o The control unit is mainly responsible for controlling all the units of operations in the computers.
  - o The control unit obtains instructions from the program stored in main memory, interprets the instructions & issues signals that cause other units of the system to execute them.
- Arithmetic Logic Unit (ALU):
  - o ALU is the place where the actual execution of the instruction takes place.
  - o All the calculations & comparisons are performed in ALU.
  - o Almost all ALUs are designed to perform the four basic arithmetic operations – Addition, subtraction, multiply, divide
- Registers:

- Registers are a small high-speed memory area, used by CPU to store temporary results & certain control information.
- Each register has a certain size & function.
- Registers can be read & written at high speed since they are internal to CPU.
- Storage Unit
- This unit holds all the data to be processed & instructions required for processing, intermediate results of processing & final results of processing before these results are released to an output unit.
- There are two types of storage unit as below :

#### 1) PRIMARY STORAGE/MAIN MEMORY/TEMPORARY STORAGE

- It holds the part of instructions & data of currently running program, intermediate results of processing & final results of processing until it is transferred to some appropriate space.
- The CPU can access the content of RAM directly.
- It has limited storage capacity.
- It is expensive.
- It is Volatile, means, it loses contents if power supply is cut off.
- It is faster than secondary storage.
- Example: RAM, ROM, cache etc.

#### 2) SECONDARY STORAGE/AUXILIARY MEMORY/PERMANENT STORAGE

- It is used to store large amount of instruction & data.
- C.P.U. is not capable of directly accessing the data & programs residing on this secondary storage.
- So if, data needs to be processed or instruction needs to be executed, it must be transferred to primary storage.
- It is cheaper than primary memory/storage.
- It is non-volatile. Means, it retains the contents even if power supply is cut off.
- It is slower than primary storage.
- Example: Hard Disk, CD, DVD, floppy disk etc.

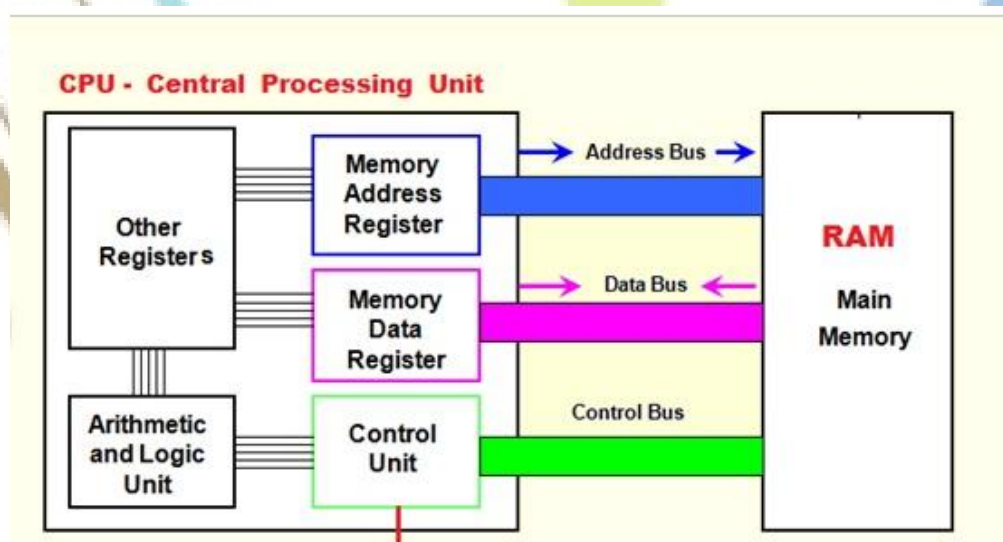
DIFFERENCE BETWEEN PRIMARY MEMORY & SECONDARY MEMORY

	Primary Memory	Secondary Memory
Name	Also known as Main Memory	Also known as Auxiliary Memory
Storage	It stores programs & data which are currently needed by CPU	The information which is not currently needed is placed in secondary memory
Speed	It is faster than Secondary Memory	It is slower as compared to Primary memory
Capacity	Its storage capacity is low	It has high storage capacity as compared to Primary memory
CPU	CPU directly communicate with Primary Memory	CPU does not directly communicate with secondary memory.
Location	Primary memory is on the Motherboard	Secondary memory is external memory.
Material Used	Semi-conductor memory is used as primary memory	Magnetic or optical memory is used as secondary memory
Example	RAM, ROM	Hard disk, CD, DVD

## BUS

A bus is a pathway for digital signals to rapidly move data. The system bus is an internal bus, intended to connect the processor with internal hardware devices. Bus is a group of conducting wires which carries information, all the peripherals are connected to microprocessor through Bus.

There are three internal buses associated with processors: the data bus, address bus, and control bus.



The address bus is used by the CPU to send the address of the memory location or the input/output port that is to be accessed at the instant. It is a unidirectional bus i.e. the address can be transferred in one direction only and that is from CPU to the required port or location.

Whether it is a read operation or write operation the CPU calculates the address of the required data and sends it on the data bus for the execution of the required operation. The maximum number of memory locations that can be accessed in a system is determined by the number of lines of an address bus. An address bus of  $n$  lines can be addressed at the most  $2^n$  locations directly.

## DATA BUS

A data bus is used to carry the data and instructions from the CPU to memory and peripheral devices and vice versa. Thus it is a bidirectional bus. It is one of most important parts of the connections to the CPU because every program instruction and every byte of data must travel across the bus at some point.

The size of the data bus is measured in bits. The data bus size has much influence on the computer architecture. Generally, a microprocessor is called  $n$ -bit processors. Thus as the CPU became more advanced, the data bus grew in size. A 64-bit data bus can transfer 8 bytes in every bus cycle and thus its speed is much faster as compared to the 8-bit processor that can transfer one byte in every bus cycle.

## CONTROL BUS

A control bus contains various individual lines carrying synchronizing signals that are used to control. Various peripheral devices connected to the CPU. The common signals that are transferred to the control bus from CPU to devices and vice versa are memory read, memory writes, I/O read, I/O write etc.

Signals are designed, keeping in mind, of the microprocessor and the requirement of the various devices connected to the CPU. So different types of the microprocessor have different control signals.

## VIRTUAL MEMORY AND CACHE MEMORY

### CACHE MEMORY

Cache Memory is a faster memory used by the central processing unit (CPU). It is a memory that helps to reduce the access time for files or data that is recently used by the main memory. It is smaller in size, high-speed memory, and located near a processor core that stores the copies of the information or instruction frequently used by the main memory locations.

it behaves like a buffer between the CPU and the main memory to hold those data or programs most frequently called by the CPU. When the program's copy is already available to the cache memory, it directly calls the processor to execute it; otherwise, the program/files are fetched from memory. Hence, it reduces the access time of the data from the main memory.

### ADVANTAGES OF CACHE MEMORY

1. The access time of files or instruction in the cache memory is less than the main memory.
2. It stores frequently used data by the main memory.
3. It is the faster computer memory as compared to the main memory.
4. Store the program in a cache memory that is executed within a short time.

### DISADVANTAGES OF CACHE MEMORY

1. It has limited space to store the data.
2. It is very costly as it is a fast memory to access the data.

### VIRTUAL MEMORY

Virtual Memory is used in the computer memory to increase the storage capacity of the main memory. It is a logical storage unit of a computer that creates an illusion to execute a large program that may not be completely placed in the main memory. Furthermore, it allows the user to load or store the data program or files larger than the size of the main memory.

### ADVANTAGES OF VIRTUAL MEMORY

1. Virtual Memory allows the users to run more than one application at once.
2. It enhances the degree of multiprogramming in the virtual memory.
3. Virtual Memory is a logical unit of computer memory that increases the main memory capacity by storing or executing a large size program than the main memory.
4. It does not require any fixed limit on the degree of multiprogramming.
5. It increases the CPU utilization in the virtual memory.
6. It is required whenever the system does not have much space to store any big programs or files.

### DISADVANTAGES OF VIRTUAL MEMORY

1. Virtual Memory can slow the process of application in the system.
2. It may take more time to switch between the applications.
3. It reduces the stability of the system.
4. It allows the user to lesser hard disk space for its use in the system.

### DIFFERENCE BETWEEN CACHE MEMORY AND VIRTUAL MEMORY

S. N.	Parameter Difference	Cache Memory	Virtual Memory
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1.	<b>Definition</b>	Cache Memory is the high speed of computer memory that reduces the access time of files or documents from the main memory.	Virtual Memory is a logical unit of computer memory that increases the capacity of main memory by storing or executing programs of larger size than the main memory in the computer system.
2.	<b>Memory Unit</b>	Cache Memory is defined as a memory unit in a computer system.	Virtual Memory is not defined as a memory unit.
3.	<b>Size</b>	Its size is very small as compared to Virtual Memory.	Its size is very large as compared to the Cache Memory.
4.	<b>Speed</b>	It is a high-speed memory as compared to Virtual Memory.	It is not a high-speed memory as compared to the Cache Memory.
5.	<b>Operation</b>	Generally, it stores frequently used data in the cache memory to reduce the access time of files.	The virtual memory keeps those data or programs that may not completely be placed in the main memory.
6.	<b>Management</b>	Cache Memory is controlled by the hardware of a system.	Whereas the virtual memory is control by the Operating System (OS).
7.	<b>Mapping</b>	It does not require a mapping structure to access the files in Cache Memory.	It requires a mapping structure to map the virtual address with a physical address.

## HARDWARE COMPONENTS

### MOTHERBOARD :

A motherboard is the main circuit board inside a computer that connects the different parts of a computer together. It has sockets for the CPU, RAM and expansion cards and it also hooks up to hard drives, disc drives and front panel ports with cables and wires.

Motherboard is also known as a mainboard, planar board or logic board, system board. It links all the individual parts of a computer together and also, allows the CPU to access and control these separate parts. Other than bridging internal components, the motherboard ports also allows you to connect external devices to the computer.

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## THE FUNCTIONS OF A COMPUTER MOTHERBOARD ARE AS FOLLOWS:

- i. The motherboard acts as the central backbone of a computer on which other modular parts are installed such as the CPU, RAM and hard disks.
- ii. The motherboard also acts as the platform on which various expansion slots are available to install other devices / interfaces.
- iii. The motherboard is also responsible to distribute power to the various components of the computer.
- iv. They are also used in the coordination of the various devices in the computer and maintain an interface among them.

### CPU chip

CPU or processor chip is a main component of Mother board. It processes the data and controls the function of computer.

### Co-processor chip

The function of this chip is to help CPU chip.

### Memory Chips

A memory slot, memory socket, or RAM slot allows RAM (computer memory) to be inserted into the computer. Most motherboards have two to four memory slots, which determine the type of RAM used with the computer. The most common RAM types are SDRAM and DDR for desktop computers and SODIMM for laptop computers, each having various types and speeds.

### Expansion Slots .

Alternatively known as a bus slot or expansion port, an expansion slot is a connection or port inside a computer on the motherboard or riser card. It provides an installation point for a hardware expansion card to be connected. For example, if you wanted to install a new video card in the computer.

### Buses(check page no 4)

### System clock

It is used to synchronize the activities of various components.

### ROM BIOS

Basic Input/Output System, the BIOS is a ROM chip found on motherboards that allows you to access and set up your computer system at the most basic level. The BIOS includes instructions on how to load basic computer hardware. It includes a test referred to as a POST (Power-On Self-Test) that helps verify the computer meets requirements to boot up properly. If the computer does not pass the POST, you hear a combination of beeps indicating what is malfunctioning in the computer.

### **main functions of a PC BIOS?**

- POST - Test the computer hardware and make sure no errors exist before loading the operating system.
- Bootstrap Loader - Locate the operating system. If a capable operating system is located, the BIOS will pass control to it.
- BIOS drivers - Low-level drivers that give the computer basic operational control over your computer's hardware.
- BIOS setup or CMOS setup - Configuration program that allows you to configure hardware settings including system settings, such as date, time, and computer passwords.

### Battery

It is used to power clock and BIOS.

### Ports

It is used for connection devices like keyboard, mouse, printer etc.

### NIC(Network Interface Cards / Network card/Network Adapter)

It is a piece of computer hardware designed to allow computers to communicate over a network.

### SMPS(Switched Mode Power Supply)

It is an electronic power supply unit that stabilize the output voltage.

Types of Processor (CPU and GPU)

## Understanding processor speed

Most computer applications require that the computer system meets minimum requirements in order for the installation to run. One of those requirements is processor speed. Processor speed measures (in megahertz or gigahertz; MHz or GHz) the number of instructions per second the computer executes.

Cycles are groupings of information – a cycle is "completed" when all of the instructions in the group have been processed. Processor speed is the number of cycles per second at which the central processing unit of a computer operates and is able to process information. Processor speed is measured in megahertz and is essential to the ability to run applications.

The CPU speed tells you how quickly your processor can perform tasks. The speed is technically measured in terms of clock speed, which is the speed of the oscillator that dictates how quickly the processor runs.

## MEMORY – RAM(SRAM,DRAM, SDRAM), ROM, EPROM, EEPROM

### WHAT IS RAM?

RAM (Random Access Memory) is the hardware in a computing device where the operating system (OS), application programs and data in current use are kept so they can be quickly reached by the device's processor. RAM is the main memory in a computer. It is much faster to read from and write to than other kinds of storage, such as a hard disk drive (HDD), solid-state drive (SSD) or optical drive.

Random Access Memory is volatile. That means data is retained in RAM as long as the computer is on, but it is lost when the computer is turned off.

## TYPES OF RAM

RAM comes in two primary forms:

**Dynamic Random Access Memory (DRAM)** makes up the typical computing device's RAM, it needs that power to be on to retain stored data.

Each DRAM cell has a charge or lack of charge held in an electrical capacitor. This data must be constantly refreshed with an electronic charge every few milliseconds to compensate for leaks from the capacitor. A transistor serves as a gate, determining whether a capacitor's value can be read or written.

**Static Random Access Memory (SRAM)** also needs constant power to hold on to data, but it doesn't need to be continually refreshed the way DRAM does.

In SRAM, instead of a capacitor holding the charge, the transistor acts as a switch, with one position serving as 1 and the other position as 0. Static RAM requires several transistors to retain one bit of data compared to dynamic RAM which needs only one transistor per bit. As a result, SRAM chips are much larger and more expensive than an equivalent amount of DRAM.

**SDRAM** stands for **Synchronous Dynamic Random Access Memory**. It synchronizes itself with the computer's system clock. This makes it easy to manage faster, and the speed of the SDRAM measured in MHz instead of nanoseconds.

### ADVANTAGES

- It is faster as compared to the other versions of RAM.
- It is more efficient, which is up to 4 times the performance of the other standard DRAMs.
- Has name suggest, it gets synchronized with the system clock.

### DISADVANTAGES

- It can't use with the older motherboards.
- It works in a single data rate, i.e., it can do only tasks per clock cycle.
- **ROM**, which stands for read only memory, is a memory device or storage medium that stores information permanently. It is also the primary memory unit of a computer along with the random access memory (RAM). It is called read only memory as we can only read the programs and data stored on it but cannot write on it. It is restricted to reading words that are permanently stored within the unit.

ROM

ROM contains special internal electronic fuses that can be programmed for a specific interconnection pattern (information). The binary information stored in the chip is specified by the designer and then embedded in the unit at the time of manufacturing to form the required interconnection pattern (information). Once the pattern (information) is established, it stays within the unit even when the power is turned off. So, it is a non-volatile memory as it holds the information even when the power is turned off, or you shut down your computer. The BIOS program, which is also present in the computer memory (ROM) is used by the microprocessor of the computer to start the computer during the booting process. It allows you to open the computer and connects the computer with the operating system.

### ERASABLE AND PROGRAMMABLE READ ONLY MEMORY (EPROM):

EPROM is a type of ROM that can be reprogramed and erased many times. The method to erase the data is very different; it is done through a specific frequency of ultraviolet light is passed for around 40 minutes to erase the data. So, it retains its content until it is exposed to the ultraviolet light. You need a special device called a PROM programmer or PROM burner to reprogram the EPROM.

### ELECTRICALLY ERASABLE AND PROGRAMMABLE READ ONLY MEMORY (EEPROM):

ROM is a type of read only memory that can be erased and reprogrammed repeatedly, up to 10000 times. It is also known as Flash EEPROM as it is similar to flash memory. It is erased and reprogrammed electrically without using ultraviolet light. Access time is between 45 and 200 nanoseconds.

The data in this memory is written or erased one byte at a time; byte per byte. It is used for storing a small amount of data in computer and electronic systems and devices such as circuit boards.

**Uses:** The BIOS of a computer is stored in this memory.

### STORAGE DEVICES – HARD DISK, CD, DVD, USB FLASH MEMORY

#### HARD DISK:

It is a rigid magnetic disc that is used to store data. It permanently stores data and is located within a drive unit.



The hard disk is also known as a hard drive. It is a rigid magnetic disc that stores data permanently, as it is a non-volatile storage device. The hard disk is located within a drive unit on the computer's motherboard and comprises one or more platters packed in an air-sealed casing. The data is written on the platters by moving a magnetic head over the platters as they spin. The data stored on a computer's hard drive generally includes the operating system, installed software, and the user's files and programs, including pictures, music, videos, text documents, etc.

### COMPONENTS OF HARD DRIVE:

The main components of a hard drive include a head actuator, read/write actuator arm, read/write head, platter, and spindle. A circuit board, which is called the disk controller or interface board, is present on the back of a hard drive. It allows the hard drive to communicate with the computer.

### COMPACT DISK (CD):



Compact Disk is a portable secondary storage device in the shape of a round medium disk. It is made of polycarbonate plastic. In the beginning, it was used for storing and playing sound recordings, later it was used for various purposes such as for storing documents, audio files, videos, and other data like software programs in a CD. The data or information is stored or recorded or encoded in CD digitally using a laser beam that etches tiny indentations or bumps on its surface. The bump is called a pit, which represents the number 0. Space, where the bump is not created, is called land, and it represents the number 1. Thus, the data is encoded into a compact disc by creating pits (0) and lands (1). The CD players use laser technology to read the optically recorded data.

### DVD:

DVD is short for digital versatile disc or digital video disc. It is a type of optical media used for storing optical data. Although it has the same size as a CD, its storage capacity is much more than a CD. So, it is widely used for storing and viewing movies and to distribute software programs as they are too large to fit on a CD. DVD was co-developed by Sony, Panasonic, Philips, and Toshiba in 1995.

### TYPES OF DVDS:

DVDs can be divided into three main categories which are as follows:

- **DVD-ROM (Read-Only):** These types of DVDs come with media already recorded on them, such as movie dvds. As the name suggests, data on these discs cannot be erased or added, so these discs are known as a read-only or non-writable DVD.
- **DVD-R (Writable):** It allows you to record or write information to the DVD. However, you can write information only once as it becomes a read-only DVD once it is full.
- **DVD-RW (Rewritable or Erasable):** This type of discs can be erased, written, or recorded multiple times.

## PEN DRIVE:

Pen drive is a compact secondary storage device. It is also known as a USB flash drive, thumb drive or a jump drive. It connects to a computer via a USB port. It is commonly used to store and transfer data between computers. For example, you can write a report using a computer and then copy or transfer it in the pen drive. Later, you can connect this pen drive to a computer to see or edit your report. You can also store your important documents and pictures, music, videos in the pen drive and keep it at a safe place.

Pen drive does not have movable parts; it comprises an integrated circuit memory chip that stores the data. This chip is housed inside a plastic or aluminium casing. The data storage capacity of the pen drive generally ranges from 2 GB to 128 GB. It is a plug and play device as you don't need additional drives, software, or hardware to use it.

## INTRODUCTION TO SOFTWARE

### Purpose and significance of Operating System

an operating system is a type of software without which you cannot operate or run a computer. It acts as an intermediary or translation system between computer hardware and application programs installed on the computer. For example, Windows

### Major Functions of Operating System:

- **Memory management:** It manages both the primary and secondary memory such as RAM, ROM, hard disk, pen drive, etc.
- **Processor Management:** It facilitates processor management, where it decides the order for the processes to access the processor as well as decides the processing time to be allocated for each process.
- **Device/ hardware management:** The operating system also contains drivers to manage devices. A driver is a type of translation software that allows the operating system to communicate with devices, and there are different drivers for different devices as each device speaks a different language.
- **Run software applications:** It offers the environment to run or use software applications developed to perform specific tasks, for example, Ms Word, Ms Excel, Photoshop, etc.
- **Data management:** It helps in data management by offering and displaying directories for data management. You can view and manipulate files, folders, e.g., you can move, copy, name, or rename, delete a file or a folder.
- **Evaluates the system's health:** It gives us an idea about the performance of the hardware of the system.
- **Provides user interface:** It acts as an interface between the user and the hardware.
- **I/O management:** It manages the input output devices and makes the I/O process smooth and effective.

- **Security:** It has a security module to protect the data or information stored in the memories of the computer against malware and unauthorized access. Thus, it not only manages your data but also helps to protect it.
- **Time Management:** It helps CPU in time management. The Kernel OS keeps checking the frequency of processes that requests CPU time. When two or more processes that are equally important compete for the CPU time, then the CPU time is sliced into segments and allocated to these processes in a round-robin fashion to prevent a single process from monopolizing the CPU.
- **Deadlock Prevention:** Sometimes a resource that is supposed to be shared by two or more processes is held by one process due to which the resource cannot continue. This situation is known as deadlock. The OS does not let this situation arise by carefully distributing the resources among the different processes.
- **Interrupt Handling:** OS also responds to interrupts, which are signals generated by a program or a device to seek the attention of the CPU. The OS checks the priority of the interrupt, and if it is more important than the currently running process, it stops the execution of the current process and preserves this state of CPU then executes the requested process. Thereafter the CPU returns to the same state where it was stopped.

Concept of System Software and Application Software(covered in unit 1)

